PB82-248030

A Study of Persistent Elevated Pollution Episodes in the Northeastern United States

Environmental Measurement, Inc.
University City, MO

Prepared for

Environmental Sciences Research Lab.
Research Triangle Park, NC

1982

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RE PB82-248030
EPA 600/J-81-447		

4. TITLE AND SUBTITLE	5. REPORT DATE
A STUDY OF PERSISTENT ELEVATED POLLUTION EPISODES IN THE NORTHEASTERN UNITED STATES	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) William M. Vaughan, Michael Chan, Bruce Cantrell and Francis Pooler	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Measurements, Inc. 8505 Delmar Blvd. University City, MO 63124	10. PROGRAM ELEMENT NO. CDTA1D/02-0241 (FY-81)
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Sciences Research Laboratory - RTP, NC Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE EPA/600/09

15. SUPPLEMENTARY NOTES

Bullentin of the American Meterological Society, Vol. 63, No. 3, March 1982

16. ABSTRACT

To examine chemical transformation within stagnant air masses and the atmospheric processes acting upon such air masses, the U.S.E.P.A. sponsored a study in the summer of 1980 in the northeastern United States. Ten research aircraft and several mobile and stationary surface monitoring platforms from three EPA contractors, seven federal agencies and four universities participated in an intensive measurement program between 16 July and 15 August 1980. Pollutants of interest included SO_2, NO, NO_x, HC, O_3, sulfate, nitrate and aerosols in general.

This paper summarizes the activities of these research aircraft. The three aircraft and one helicopter operated by the contractor team logged a total of 353 flight hours during 100 missions in the program. Flights were made from Columbus, Ohio to as far east as Laconia, New Hampshire, as far south as Montgomery, Alabama, as far west as Texarkana, Arkansas, and as far north as Saginaw, Michigan. The flight patterns and data collected for each mission are documented. This summary will allow scientists who are interested in this data base to identify subsets of the data for model development.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
RELEASE TO PUBLIC	UNCLASSIFIED	
	20. SECURITY CLASS (This page) UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

EPA 600/J-81-447

Reprinted from BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY, Vol. 63, No. 3, March 1982
American Meteorological Society
Printed in U. S. A.

A Study of Persistent Elevated Pollution Episodes in the Northeastern United States

WILLIAM M. VAUGHAN,[1] MICHAEL CHAN,[2] BRUCE CANTRELL,[3] AND FRANCIS POOLER[4]

A Study of Persistent Elevated Pollution Episodes in the Northeastern United States

William M. Vaughan,[1] Michael Chan,[2] Bruce Cantrell,[3] and Francis Pooler[4]

Abstract

To examine chemical transformation within stagnant air masses and the atmospheric processes acting upon such air masses, the United States EPA sponsored a study in the summer of 1980 in the northeastern region of the country. Ten research aircraft and several mobile and stationary surface monitoring platforms from three EPA contractors, seven federal agencies, and four universities participated in an intensive measurement program between 16 July and 15 August 1980. Pollutants of interest included SO_2, NO, NO_x, HC, O_3, sulfate, nitrate, and aerosols in general.

This paper summarizes the activities of these research aircraft. The three aircraft and one helicopter operated by the contractor team logged a total of 353 flight hours during 100 missions in the program. Flights were made from Columbus, Ohio, to as far east as Laconia, N.H., as far south as Montgomery, Ala., as far west as Texarkana, Ark., and as far north as Saginaw, Mich. The flight patterns and data collected for each mission are documented. This summary will allow scientists who are interested in this data base to identify subsets of the data for model development.

1. Introduction

The Regional Field Studies Office (RFSO) of the United States Environmental Protection Agency (EPA) sponsored a field study in July–August 1980, which was designed to examine the transport and chemical transformation of polluted air masses extending over hundreds of kilometers. These air masses, called Persistent Elevated Pollution Episodes (PEPEs) have been noted in recent years because of satellite imagery that clearly shows the broad regions of haze characteristic of such stagnant systems (Lyons *et al.*, 1978). Reports of surface visibility and air quality patterns have been correlated with these air masses (Husar *et al.*, 1976a; Husar *et al.*, 1976b; Wolff *et al.*, 1981). Field studies in 1978 recognized the need for regional scale measurements (Schiermeier *et al.*, 1979).

EPA's Meteorology Division was a cosponsor of the field study. It desired to examine the dynamics of oxidant formation, transport, and removal in developing a data base for the EPA northeast regional oxidant model. Its focus was on regional characterizations as well as detailed understanding of urban plume dynamics for providing various parameters to the model. The Meteorology Division's activities were organized as the North East Regional Oxidant Study (NEROS).

The resources and platforms necessary to perform these two studies were combined and coordinated from a common headquarters in Columbis, Ohio, between 16 July and 15 August 1980. In this way, a common weather forcasting, data processing, and communications center could serve both projects as one. In addition, when conditions were not optimum for one project's scenario but suitable for the other, measurement platforms could be easily shifted to execute those measurements.

This paper provides an overview of the participants, the measurement platforms, the parameters surveyed and the geographic range of measurement missions during the PEPE/NEROS study. It is hoped that the perspective on the study's scope and operations will make its extensive data base meaningful for more potential users. The data base will grow as validated data sets from each platform are added to it. Completion of the validation process will be within 1982.

2. Participants

The PEPE/NEROS study involved a mix of contractors, government agencies, and universities, as well as international experts. Table 1 gives an overview of the participating organizations. The contractor team of four organizations provided measurement platforms, general support, and overall coordination. The team consisted of Environmental Measurements, Inc. (EMI), AeroVironment Inc. (AV), SRI-International (SRI), and Washington University Technology Associates (WUTA). William M. Vaughan of EMI served as Project Director, Ivar Tombach of AV and Bruce Cantrell of SRI as Co-Directors, and Michael Chan of AV as Field Manager.

Seven governmental agencies were involved in management, measurement, and field support roles. The RFSO and Meteorology Division of EPA's Environmental Sciences Research Laboratory (ESRL) provided technical direction and support activities from Francis Pooler and William E. Wilson, Jr. of RFSO, and from Ken Demerjian, Jason

[1]Environmental Measurements, Inc., 8505 Delmar Blvd., University City, Mo. 63124.
[2]AeroVironment Inc., 145 N. Vista Ave., Pasadena, Calif. 91107.
[3]SRI-International, 333 Ravenswood, Menlo Park, Calif. 94025.
[4]EPA Regional Field Studies Office, Research Triangle Park, N.C. 27711.

0003–0007/82/030258–09$06.25
1982 American Meteorological Society

TABLE 1. Participants in the PEPE/NEROS study.

Agencies	Contractors
U.S. Environmental Protection Agency	Environmental Measurements, Inc.
ESRL—Research Triangle Park	AeroVironment Inc.
EMSL—Research Triangle Park	SRI-International
EMSL—Las Vegas	Washington University Technology Associates
National Oceanic and Atmospheric Administration	MESOMET Inc
Boulder Laboratories	Battelle Columbus Laboratories
Idaho National Engineering Laboratory	Research Triangle Institute
National Science Foundation	PEDCO Environmental
National Center for Atmospheric Research	**Universities**
National Aeronautics and Space Administration	Washington University
Langley Research Center	Harvey Mudd College
Jet Propulsion Laboratory	Ohio State University
Wallops Island	Others, indirectly through the agencies
Department of Energy	**International**
Argonne National Laboratory	Atmospheric Environment Service of Canada
Federal Aviation Administration	Millan M. Millan of Barringer Research
Tennessee Valley Authority	N.D. van Egmond, Rijks Instituut voor de Volksgezondheid
Ohio Environmental Protection Agency	Bertin & Cie

Ching, and John Clarke of the Meteorology Division. Also involved from EPA were the Environmental Monitoring Support Laboratories (EMSL) in North Carolina and Las Vegas.

The National Oceanic and Atmospheric Administration (NOAA) provided support from their Boulder Laboratories and the Idaho National Engineering Laboratory (INEL). The Boulder Labs specialized in turbulence, land use, and energy budget measurements, while the crew from INEL released and tracked small tetroons. EPA supported extra radiosonde launches by NOAA to achieve a six-hour sounding schedule at 12 sites within the general northeastern study area.

The National Science Foundation (NSF) provided funding to the National Center for Atmospheric Research (NCAR) for studies of precipitation processes near the PEPE/NEROS study area.

Federal Aviation Administration (FAA) facilities were used to track EPA's large tetroons, which were equipped with aircraft transponders. This tracking effort was staffed and coordinated by SRI-International from various FAA centers across the greater northeast.

The National Aeronautics and Space Administration (NASA) flew several airborne lidar systems for ozone and aerosols and an in situ sampling aircraft, and operated several advanced ground-based meteorological systems. The Department of Energy, through Argonne National Laboratory (ANL), made turbulent dry deposition measurements at Croton, Ohio, (NE of Columbus). At the same location, NASA conducted many of its ground-based operations.

The Tennessee Valley Authority (TVA) provided one of its monitoring helicopters to carry EPA instruments for urban air mass characterization. The Ohio Environmental Protection Agency cooperated with PEPE/NEROS participants in the use of their laboratory space and monitoring facilities.

In addition to Washington University's involvement through WUTA, there were other university groups involved in PEPE/NEROS. Washington University's Center for Air Pollution Impact and Trend Analysis (CAPITA) provided regional dispersion modeling output and specialized plots of National Weather Service data. The University of Minnesota operated its mobile laboratory, designed for sophisticated aerosol and chemical measurements, at the ANL/NASA site. Harvey Mudd College provided specialized measurements related to oxidant photochemistry at two EPA ground monitoring sites. Ohio State University provided general meteorological and tetroon trajectory support in addition to airport and operational facility support. Several other university researchers participated indirectly through various agencies.

Private contractors and consultants, outside the main contractor team, were involved as well. Battelle Columbus Laboratories provided support for three NO-NO_x ground stations and EPA's mobile gas chromatography laboratory. MESOMET, Inc., which was in daily contact with the project's weather room, provided verbal interpretation and hard copy information from the GOES satellites, and digitally archived meteorological conditions during the study period (Lyons and Calby, 1981). Research Triangle Institute (RTI) and PEDCO Environmental (PEDCO) provided external system audits.

International participation in PEPE/NEROS came from several countries. The Atmospheric Environment Service (AES) of Canada was involved on a daily basis by providing hard copies of trajectory, SO_2, and sulfate predictions from

TABLE 2. Platforms and data centers operated during PEPE/NEROS.

Airborne laboratories	Source	Principal investigator
CHEM-1 (Chemistry aircraft)	EMI	William Vaughan
CHEM-2 (Chemistry aircraft)	AV	Ivar Tombach
SCOUT (Chemistry aircraft)	SRI	Bruce Cantrell
ELECTRA (Lidar system)	NASA	Ed Browell (UV-DIAL*) Jeffrey Scroga (HSRL*)
CHEM-3 (Chemistry aircraft)	NASA	Gerald Gregory
LAS* Queenair	NASA-JPL	Mike Schumate
EPA-Lidar	EPA-Las Vegas	Jim McElroy
Turbulence aircraft	NOAA-Boulder	Brad Bean
Cloud chemistry aircraft	NCAR	Al Lazarus
CHOPPER	EPA-TVA-EMI	William Vaughan
Surface-based laboratories	**Source**	**Principal investigator**
Moving laboratory	EMI	Gary Klauber
Doppler Sodar 1 and 2	AV	Michael Chan
Aerosol laboratory	Univ. of Minn.	Peter McMurray
Lidar van	SRI	Ed Uthe
Small tetroon tracking	NOAA-Idaho	Gene Start
Large tetroon tracking	SRI	Walt Dabberdt
GC laboratory	ESRL-RTP	William Lonneman
Special photochemistry precursors	Harvey Mudd College[1]	Gregory Kok[1]
Tethered balloon	NASA	Otto Youngbluth
NO_y, Ozone network	EMI-BCL	William Vaughan
Bertin sodar	Bertin & Cie	Pierre Huguet
Dry deposition experiment	ANL	Marvin Wesley
MARS*	NASA-JPL	Bruce Gary
Sun photometry	NASA–U. of Miami	Joe Prospero
Data center	WUTA	Noor Gillani
Weather center	SRI	William Viezee

[1]Now at NCAR, Boulder, Colo.
*UV-DIAL – Ultraviolet-Differential Absorption Lidar.
HSRL – High Spectral Resolution Lidar.
LAS – Laser Absorption Spectrometer.
MARS – Microwave Atmospheric Remote Sensor.

the Canadian LRTAP trajectory and concentration model (Olson and Oikawa, 1980). Bertin and Cie of France shipped a Doppler acoustic sounder to the Columbis, Ohio, area for continuous operation during the field study. Individuals from Canada (Millan M. Millan) and the Netherlands (N.D. van Egmond) provided advisory guidance in the planning stages of the overall program.

3. Platforms

The participants (Table 1) carried out air quality and meteorological measurements from surface platforms (fixed, mobile, and moving) and airborne platforms. Some provided support services involving data acquisition and archiving at the field headquarters. Table 2 provides a summary of these measurement platforms and data centers, indicating the organization and Principal Investigator responsible for each set of data gathered.

Most platforms operated were based in the vicinity of Columbus, Ohio. The major exceptions were the NEROS operations in the Baltimore-Washington, D.C., corridor (only loosely coordinated out of Columbus, Ohio) and the NCAR precipitation chemistry measurements, which operated in the greater northeast but were not coordinated with the bulk of the program.[5] Figure 1 indicates when the program platforms were operating, with the exception of the two activities mentioned above. If any measurements were made on a given day, the appropriate date column is marked.

4. Parameters

A diverse mixture of measurements is possible from the platform list (Table 2). Within the collection of measurements from PEPE/NEROS is information on gaseous pollutants (particularly SO_2, NO, NO_y, O_3, and hydrocarbons); aerosol indicators (b_{scat}, $SO_4^=$, Aitken nuclei count, aerosol

[5]It should be noted that EPA, through the Office of Air Quality Planning and Standards, operated the Northeast Corridor Regional Monitoring Program (NECRMP) during the summer of 1980 from Baltimore to Boston. The program involved augmented air quality and meteorological measurements. These data are valuable in characterizing the eastern edge of the study grid.

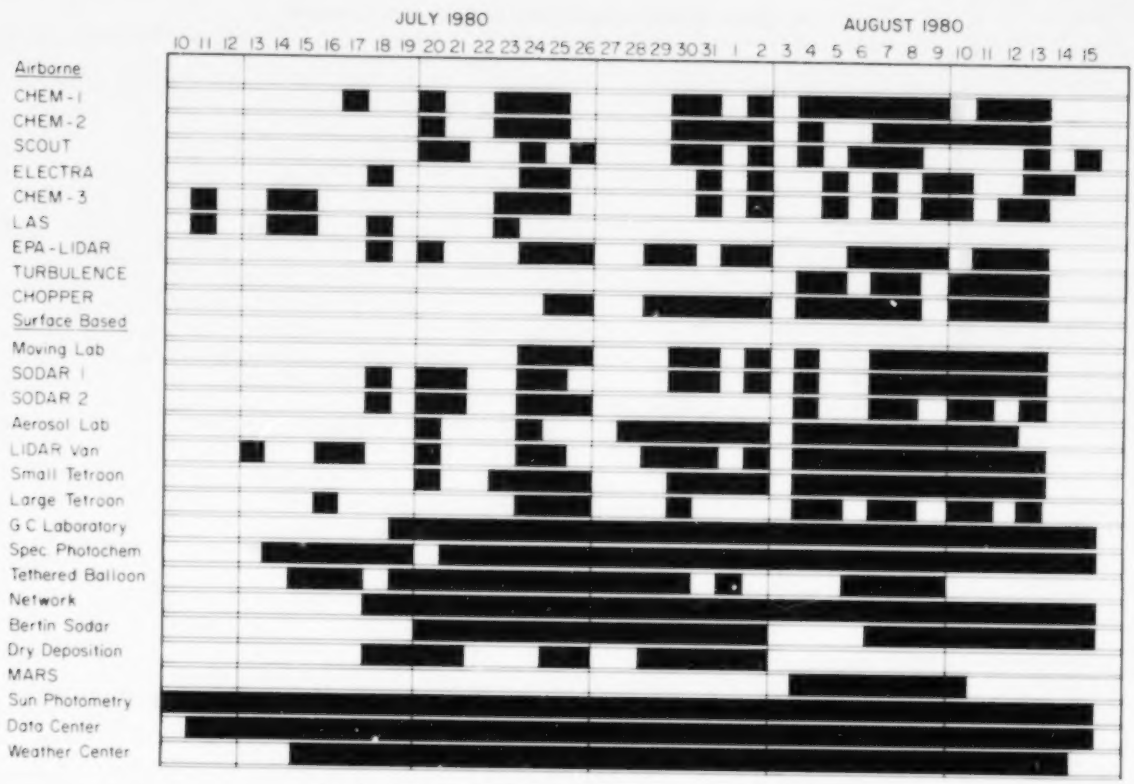

FIG. 1. Days of operation of platforms during PEPE/NEROS.

filters, chemical analyses, and particle size distribution); and meteorological parameters (multiple tetroon trajectories, temperature, wind speed, dew point, and mixing height (from the various lidar measurements)). Vertical profiles of these parameters exist from spiral flights and ramping flights, while horizontal gradients are available on a large scale for regional missions and on an intermediate scale for urban plume missions. All the aircraft automatically recorded their position (x, y, z) and time (CDT) so that spatial and temporal linking of the data base is possible. A total of 353 flight hours were logged by CHEM-1, CHEM-2, SCOUT, and CHOPPER in 100 missions flown by the EPA contractor teams.

Table 3 indicates which air quality and meteorological parameters were recorded by each platform. Not all parameters were necessarily recorded for each day, but most parameters for most days should be generally available.

WUTA's Data Center provided 24 h processing of data tapes from the principal contractor aircraft (CHEM-1, CHEM-2, and SCOUT) to rapidly pinpoint problem areas with instrumentation, and assure timely repair so that there would be maximum recovery of data on each parameter. SRI's weather center archived the NWS observations, soundings, maps, progs, and satellite photos received during the program. These real-time records are complemented by a computerized satellite and weather service data base compiled during the program by MESOMET, Inc., using the University of Wisconsin McIDAs system.

5. Operations and flights

A full operational headquarters was set up in a dormitory on the Ohio State University campus. Included in this headquarters were a complete radio and phone communications center; a complete weather center with multiple NWS wire service inputs, including GOES satellite imagery and facsimiles from AES Canada; a computer center; project office; and space for general briefings.

The daily schedule involved gathering information on platform status for each parameter (Table 3) and on forecast weather conditions. Platform operators and the data center provided information on those platforms that could be deployed for a survey mission. The study's forecaster and his staff prepared a forecast of local (Columbus, Ohio) and regional weather conditions expected for the next 24–48 h period. Input from the senior scientists in the field was utilized to plan the next day's mission, taking advantage of operating instruments, weather conditions, and various PEPE and NEROS monitoring objectives.

The NEROS missions for urban and regional studies

TABLE 3. Air quality and meteorological parameters available for each platform.

Platforms	Measurement interval (s)	SO_2	SO_4	NO–NO_x	O_3	b_{scat}	ANC	Hydrocarbons[b]	Filters[c]	Temperature	Dew point	Light levels	Turbulence	Wind speed	Wind direction
Airborne															
CHEM-1[a]	2-8	X	X	X	X	X	X	X	X	X	X				
CHEM-2	12	X	X	X	X	X	X	X	X	X	X		X		
Scout	0.4	X			X	X		X	X	X	X		X		
Electra	1–60				PRO	PRO[e]									
CHEM-3	10				X	HTD				X	X				
LAS	10–30				INT										
Turbulence	<1				X					X	X		X	X	X
Chopper	5			X	X	X		X							
EPA Lidar						PRO[e]									
Surface-based															
Moving lab	8–15	X +INT	X	X	X	X		X	X						
Sodar 1	300[d]									PRO				PRO	PRO
Sodar 2	300[d]									PRO				PRO	PRO
Aerosol lab[a]		X	X	X	X	X	X								
Lidar van		INT				PRO[e]									
Special															
Photochemical				X	X			X				X			
Tethered balloon	30				X					PRO	PRO			PRO	PRO
Network				X	X							X			
Bertin sodar	300[d]													PRO	PRO
Dry dep.		X			X					PRO	PRO			X	X
MARS	600									PRO	PRO				

X – Point measurement available.
PRO – Profile showing variations with altitude.
HTD – Heated nephelometer.
SO_4 – Continuous readings from a modified Meloy 285.
INT – Integrated burden (for SO_2 these measurements were from correlation spectrometers).
a – Aerosol size distribution measurements were conducted as well.
b – Hydrocarbon cannisters were analysed in EPA's GC Laboratory in Columbus, Ohio.
c – Filters were collected with a 3.5 μm cut point and analysed for $SO_4^=$ and NO_3^-.
d – Seven second readings reported as 15 min averages.
e – The lidar signal is not a true profile of the parameter "b_{scat}" but is related to it, since it records the backscatter of light from layers of atmospheric aerosol. It gives a good indication of mixing depth.

involved release of small tetroon clusters at various altitudes (to be tracked by NOAA-Idaho) and a large EPA tetroon to be tracked by FAA centers. Once the transport field was marked with tetroons, the aircraft and mobile platforms were deployed to document the air quality and mixing conditions in the air mass. CHOPPER and NOAA-Turbulence were fairly heavily dedicated to urban plume surveys. EPA Lidar carried out mostly plume-oriented studies, but occasionally conducted regional studies outside Ohio. Moving Lab conducted frequent ground-level surveys near Columbus, but also was deployed to West Virginia and Kentucky for PEPE-oriented regional surveys.

NEROS regional measurements were carried out to characterize the northeastern grid used in the regional oxidant model between about 70° W and 85° W longitude, and 38° N and 45° N latitude. SCOUT, CHEM-1, and CHEM-2 provided frequent in situ surveys across various parts of this NEROS box. They were usually vectored back to the loca-

TABLE 4. Schedule of missions flown.

	July								August												
	20	23	24	25	26	29	30	31	1	2	4	5	6	7	8	9	10	11	12	13	15
Urban Plume																					
Limited	X	X				X			X	X		X	X	X	X		X	X			
Full scale				X			X	X			B								X	X	(X)
Regional																					
PEPE			P						X			X	X	X	X	X	P	P			
NEROS				P			P			X					X						X

P = Power plant plumes were specifically monitored in the course of regional measurements.
B = Urban plume budget measurements.
( ) = Poor data recovery from aircraft.

tion of the large EPA tetroon, in order to follow the aging of the air mass in the vicinity of this specific marker. Moist air masses moving in from the west and southwest, and Canadian polar air masses were characterized by these flights.

ELECTRA was deployed for its regional surveys out of Wallops Island, Va., in support of NEROS and PEPE regional objectives. CHEM-3 provided correlative in situ measurements at selected locations below ELECTRA's flight path (as it had done earlier in the program for LAS-Queenair flights).

PEPE regional surveys were less restricted, and involved flights into stagnant air masses (two to five days old) or into moving air masses that experienced regional visibility degradation, as reported by FAA and NWS wire services and by satellite imagery. These regional surveys extended into New York and New England during the first week in August 1980, following development of large-scale haziness in the area. In the middle of the second week in August, several flights into Tennessee, Alabama, and Arkansas were carried out to characterize a maritime tropical air mass associated with an extension of the Bermuda High that had stagnated over Georgia and Tennessee for four days. Measurements also were made as this aged air mass swept out to the Atlantic. On two occasions, 25 July and 11 August, tetroons were placed in or near power plant plumes, and flights were made to characterize the mixing of these plumes into the general air mass.

A summary of the types of missions flown during the study period is shown in Table 4. It is obvious that with the resources available to the project, limited urban plume flights could be carried out while regional surveys were in progress. This calendar starts on 20 July, because coordinated mission-oriented activity did not start until then.

Figures 2-5 show sample flight routes of CHEM-1,

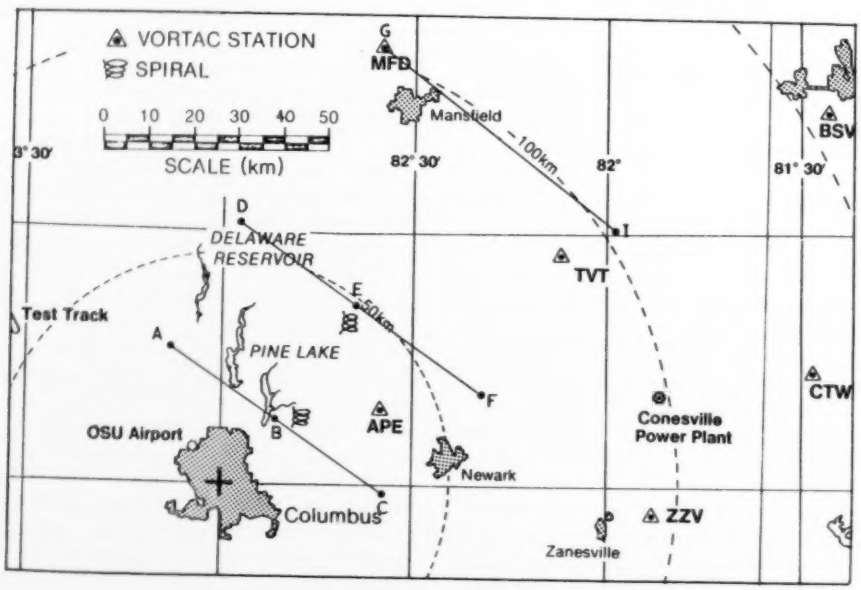

FIG. 2. Urban plume flight by CHEM-1 on 4 August 1980.

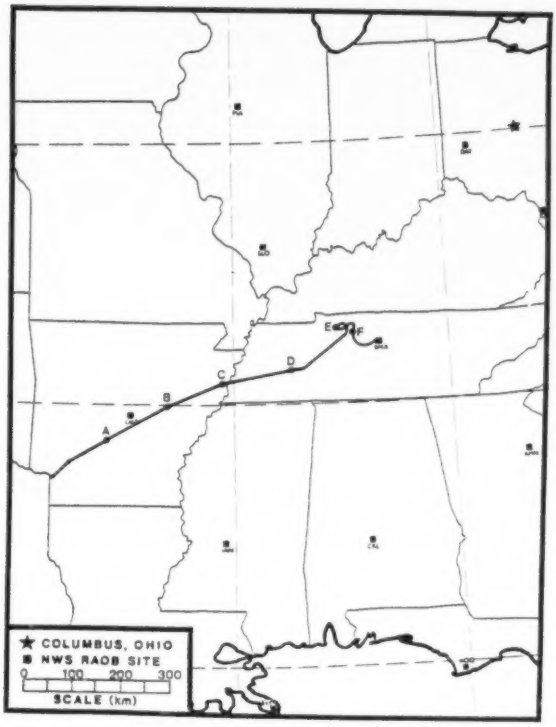

FIG. 3. CHEM-2's second flight on 10 August 1980.

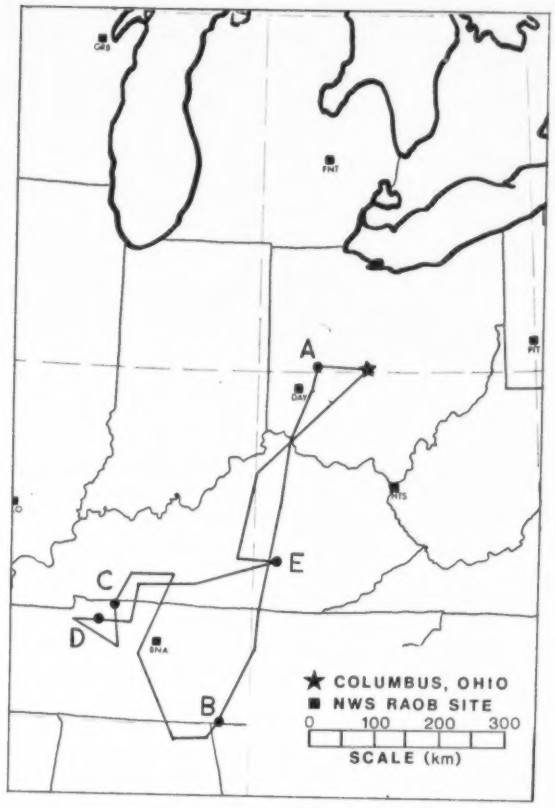

FIG. 4. CHEM-1 flight on 11 August 1980.

CHEM-2, and ELECTRA. They indicate the range of a typical urban plume mission on 4 August (Fig. 2) and the scale of PEPE flights on 10–11 August (Figs. 3–5).

6. Products of the PEPE/NEROS study

The data base from the PEPE/NEROS study is quite large, considering the number of platforms, extent of parameters measured, frequency of observations, and geographic range of measurements. A thorough quality assurance program was followed throughout to assure that, especially for the principal platforms, the data from similar instruments would be comparable. The frequent instrument calibrations were linked together by external audits by Research Triangle Institute and PEDCO. The contractor team of EMI, AV, and SRI had an additional independent internal audit system that operated throughout the study to check each contractor platform against a master calibration system. Thus, the data base is well linked and traceable to common standards.

The data base is being established at Washington University under the direction of Noor Gillani (Department of Mechanical Engineering, Washington University, St. Louis, Mo., 63130).

The value of this data base lies in the numerous new insights it will afford. We now have extensive in situ measurements within broad regional air masses that are noticeable from satellite imagery. This detailed information on the internal chemical and aerosol composition of PEPEs will allow a better understanding of the critical components of such hazy air masses. With the numerous flights across these air masses, we now have information on the horizontal and vertical gradients within them. By following these air masses for several days, we will gain knowledge of the growth in pollutant burden and its transport. Changing ratios of chemical species to aerosol components can be compared under the influence of cool, dry air (Canadian polar) with those ratios under the influence of warm, moist air (maritime tropical). This greater detail will assist in understanding the environmental factors affecting pollutant transformation and transport processes, interpreting satellite data, and forecasting future PEPE formation and migration.

With the regional measurements for the NEROS program dealing with good transport conditions within the grid used for the regional oxidant model, we have a contrast in regional conditions compared to PEPEs. Under the good transport conditions, the measurements characterize pollutant burdens resulting from aging one to two days on a regional scale, while the stagnation conditions during a PEPE lead to studies of three to five-day-old pollutant burdens. The rates of removal (studied by ANL at Croton, Ohio) and rates of formation of various chemical and aerosol species will provide inputs to the regional model, as well as provide further comparisons with PEPE conditions. The detailed study of diurnal urban plume dispersion and transport will provide a critical element for regional oxidant modeling.

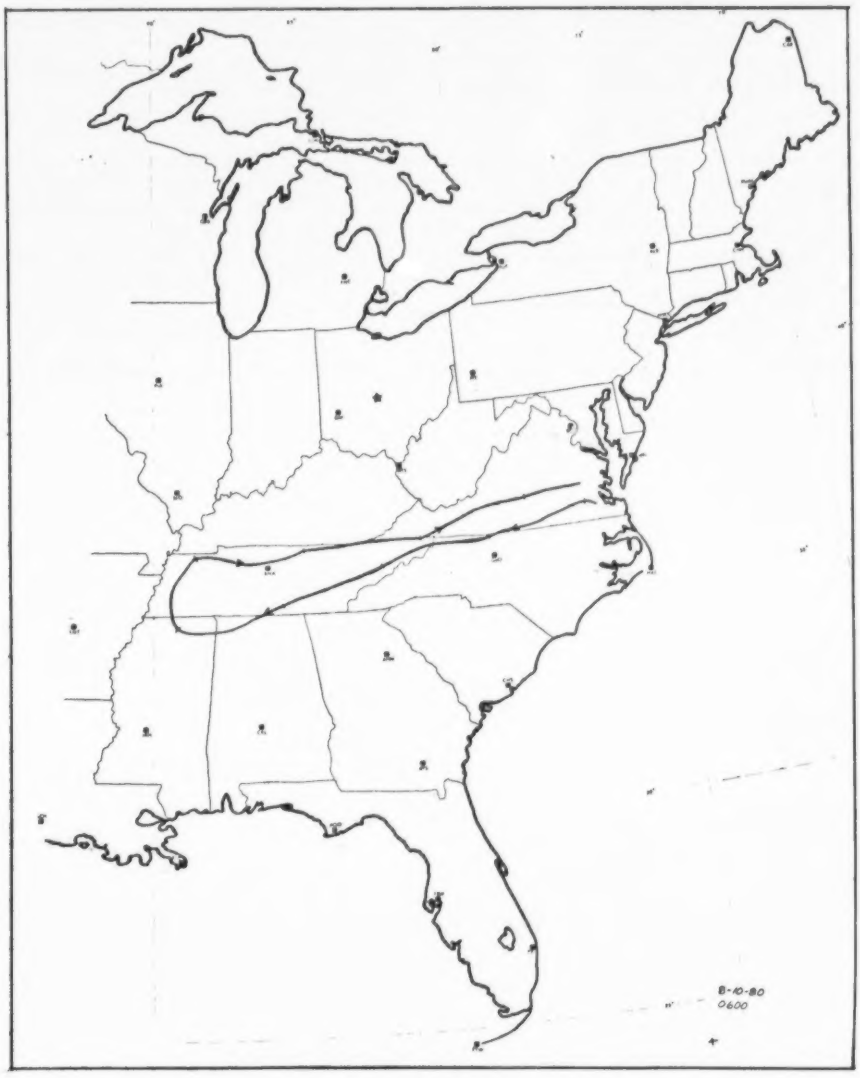

FIG. 5. ELECTRA flight on 10 August 1980.

Because many of the parameters monitored during this study are critical to the general understanding of long-range transport and the issues of acid rain, numerous analyses of the data base from those perspectives are anticipated. The numerous meteorological measurements made during the program, coupled with the air mass trajectories at different altitudes, will contribute significantly to refining long-range transport models.

The numerous smaller-scale studies within the overall PEPE/NEROS program will provide additional insights to our understanding of removal mechanisms, the utility of new remote sensing instruments, and comparisons between Los Angeles and the humid midwest in terms of photochemistry, etc. As more researchers and scientists examine and work with this data base, the scope of potential insights will expand.

Acknowledgments. The coordination and organization of this program was supported by the U.S. Environmental Protection Agency under Contract No. 68-02-3411 to Environmental Measurements, Inc. There was also substantial funding of other participants via direct support, interagency transfer, and/or joint support from NASA, NSF, NOAA, DOE, TVA, and FAA.

References

Husar, R. B., N. V. Gillani, C. Paley, and P. Turcu, 1976a: Long range transport of pollutants observed through visibility contour

maps, weather maps, and trajectory analysis. *Preprints, Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality (Raleigh, N.C.)*, AMS, Boston, pp. 344–347.

——, ——, and J. D. Husar, 1976b: Study of long range transport from visibility observations, trajectory analyses and local air pollution data. *Proceedings, 7th Technical Meeting on Air Pollution Modeling and its Applications*, NATO/CCMS, Airlie, Va., 7–10 September 1976.

Lyons, W. A., and R. H. Calby, 1981: Remote sensing technology as used in studies of persistent elevated pollution episodes (PEPEs). Presented to the Environmetrics '81 Conference, Washington, D.C., 8–10 April 1981.

———, J. C. Dooley, and K. T. Whitby, 1978: Satellite detection of long-range pollution transport and sulfate aerosol hazes. *Atmos. Environ.*, **12,** 621.

Olson, M. P., and K. K. Oikawa, 1980: Trajectory and concentration forecasts for the PEPE Project. *Rep. AQRB-81-017-T.*, Atmospheric Environment Service of Canada, Downsview, Ontario, Canada.

Schiermeier, F. A., W. E. Wilson, F. Pooler, J. K. S. Ching, and J. F. Clarke, 1979: Sulfur Transport and Transformation in the Environment (STATE): A major EPA research program. *Bull. Am. Metereol. Soc.*, **60,** 1303–1312.

Wolff, G. T., N. A. Kelly, and M. A. Ferman, 1981: On the sources of summertime haze in the eastern United States. *Science*, **211,** 703.